ADVANCES IN INTEGRATED MANAGEMENT OF PEAR POSTHARVEST DECAY

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Postharvest decay continues to be a costly problem for pear producers. However, an expanding list of materials and alternative strategies that can contribute to postharvest decay management provides greater opportunities than in the past to minimize the incidence of decay. This report will describe developments affecting programs for decay management both with and without the use of fungicides.

ORCHARD, POSTHARVEST AND STORAGE

In order to evaluate decay management programs that may provide acceptable alternatives to fungicide treatment, factorial experiments were carried out in 2003-2004 and 2004-2005 combining various orchard, postharvest, and storage factors.

Orchard

In the orchard, Bosc pear trees received either: early-season treatments with Messenger, a product based on a protein reported to induce disease resistance in some plants; summer treatments with calcium chloride; or no orchard treatment. Prior to postharvest treatments, all pears were wounded with a nail.

Postharvest

After harvest pears from each orchard plot received one of the following postharvest treatments: the standard fungicide thiabendazole (TBZ); the bacterial biocontrol product BioSave 110; sodium bicarbonate (baking soda); Storox, an oxidizing agent based on peroxyacetic acid; or chitosan, a product based on crustacean shell extracts reported to stimulate disease resistance in some plants.

Storage

After treatments, pears were stored at 31 °F in either standard perforated polyethylene liners or in LifeSpan modified atmosphere packaging. After 3-4 months, incidence of decay developing at wound sites was evaluated.

Results

The natural decay observed in this study was predominantly blue mold (caused by *Penicillium expansum*), with minor incidence of gray mold (*Botrytis cinerea*). In the first year of the study, across all postharvest treatments, calcium chloride orchard treatments reduced incidence of postharvest decay as compared with no treatment, but Messenger treatments did not reduce decay. Chitosan appeared to increase decay across all orchard treatments. Relatively low levels of decay were observed in all postharvest treatments other than chitosan, and average decay levels achieved with postharvest treatments other than chitosan were not significantly different from those provided by TBZ. These results indicate that Messenger, at least as applied in an early-season program, may not be of value in management of postharvest decay in pear. However, calcium chloride in the orchard, followed by any of the postharvest treatments studied other than chitosan, may provide decay control equivalent to that provided by TBZ.

In the second year of the study, orchard, postharvest, and storage treatments were all significant factors in reducing decay. The most effective orchard treatment was calcium chloride. The most effective postharvest treatments were sodium bicarbonate and BioSave 110, resulting in decay levels comparable to or better than those provided by thiabendazole. However, sodium bicarbonate caused the Bosc pears used in this study to darken. Chitosan also injured the fruit, resulting in an apparent increase in decay susceptibility. Excluding sodium bicarbonate due to the discoloration, the most effective sequence of orchard, postharvest, and storage treatments tested in this project was calcium chloride in the orchard, followed by BioSave 110 postharvest, followed by storage in LifeSpan modified atmosphere packaging (Table 1).

Table 1. Most effect program of combined orchard, postharvest, and storage treatments, without use of fungicides, for control of pear postharvest decay.

Year	Orchard	Postharvest	Storage	% infected wounds
Year1 2003-2004	Check	Water	Standard liner	5.7 a
	Calcium chloride	BioSave 110	LifeSpan MAP	3.3 a
Year2 2004-2005	Check	Water	Standard liner	44.2 a
	Calcium chloride	BioSave 110	LifeSpan MAP	2.1 b

PREHARVEST AND POSTHARVEST CONTROLS

Plots were established in 2004-2005 and 2005-2006 to compare various combinations of different fungicides applied in the orchard (preharvest) and subsequently applied as postharvest line sprays. Prior to postharvest treatments, all fruit were wounded with a finishing nail to simulate partial stem punctures. Natural inoculum present on the fruit surface was the source of wound infection. After receiving postharvest treatments, all fruit were stored in polyethylene-lined boxes at 31 °F for 4-5 months, when decay at wounds was evaluated.

In general, preharvest sprays with Topsin M, Flint, and Pristine were effective in reducing decay (Table 2). Postharvest treatments with Scholar or Penbotec were highly effective in reducing decay. Because of the strong control provided by those postharvest treatments, effects of specific preharvest-postharvest combinations that included Scholar and Penbotec could not be distinguished, nor an optimum combination identified. However, each of the fungicides in this study was shown in laboratory tests to have a specific spectrum of pear postharvest pathogens that it was effective in controlling. Thus preharvest-postharvest fungicide combinations should provide effective control of multiple postharvest diseases. A season-long “complete” decay control program could consist of calcium and ziram sprays during the summer, Topsin M, Flint, or Pristine before harvest (specific timing to depend on label restrictions), and Scholar or Penbotec as a postharvest treatment. As of December, 2006, Pristine and Scholar do not yet have import tolerances established in Canada. Where Mertect is used as a postharvest treatment, use of Topsin M in the orchard should be discouraged to avoid exacerbating selection for resistance in the pathogen population.

Table 2. Effects of preharvest and postharvest fungicide treatment combinations on incidence of postharvest decay in wounded, naturally-infected Bosc pears.

YEAR 1	**TOTAL DECAY (% OF WOUNDS INFECTED)**						
	Orchard sprays, application timing before harvest						
Postharvest Spray	**None**	**Ziram 1 mo**	**Flint 3 wk**	**Topsin 2 wk**	**Ziram–Flint 1 mo/3 wk**	**Ziram–Topsin 1 mo/2 wk**	**Topsin 3 days**
None	9.9 a	8.8 a	3.2 a	2.1 ab	1.1 ab	2.1 b	1.1 a
Scholar	0.5 b	0.3 c	0.3 b	1.1 a	0.3 a	0.0 a	0.0 a
Penbotec	1.3 b	0.8 bc	0.3 b	0.8 a	0.5 a	1.1 ab	0.8 a
Mertect	6.0 a	3.2 b	2.8 a	4.0 b	2.7 b	2.9 b	1.1 a

YEAR 2	**TOTAL DECAY (% OF WOUNDS INFECTED)**							
	Orchard sprays, application timing before harvest							
Postharvest spray	**None**	**Ziram 1 wk**	**Flint 1 wk**	**Topsin 1 wk**	**Pristine 1 wk**	**Ziram-Flint 1 mo/1 wk**	**Ziram-Topsin 1 mo/1 wk**	**Ziram-Pristine 1 mo/1 wk**
None	6.2 a	2.4 a	1.3 ab	1.6 ab	1.1 a	0.5 ab	1.1 a	0.8 a
Scholar	1.2 b	0.0 c	0.0 b	0.0 b	0.0 a	0.0 b	0.0 a	0.0 a
Penbotec	0.6 b	0.5 bc	0.8 ab	0.3 b	0.0 a	0.0 b	0.5 a	0.0 a
Mertect	3.2 ab	2.2 ab	2.7 a	3.5 a	0.3 a	1.1 a	3.2 a	2.1 a

In many postharvest handling operations, there can be two opportunities to apply postharvest fungicides. For example, one material could be applied in a drench immediately after harvest, followed by another material as a line spray before packing. Pre-size operations may have opportunities for line sprays during the pre-size and again before packing.

An experiment was designed to simulate the situation of two postharvest applications, and compare various combinations of how Mertect, Scholar, and Penbotec might be deployed. In this study, Bosc pears were artificially wounded with a finishing nail prior to treatment with a line spray immediately after harvest. Pears were then dipped into suspensions containing high doses of the blue mold fungus, *Penicillium expansum*. Following the initial treatment, all fruit were stored for three weeks at 31 °F, and then treated with a second line spray. After the second treatment all fruit were stored in polyethylene-lined boxes at 31 °F for two months, and then evaluated for decay at wounds. Nearly all of the wounds became infected in the check treatment (Table 3). Generally, Penbotec and Scholar were the most effective treatment materials, and the first treatment timing was the most effective one. The results indicate that the most effective available material would be best used as the first treatment in a postharvest program consisting of two treatments separated in time. An additional study indicated that by approximately three weeks (at 31 °F) after fungus spores have been introduced into wounds, fungicide treatment begins to lose effectiveness. This is probably due to the infection advancing into the tissue, where it is less likely to be contacted by the fungicide.

Table 3. Effects of sequential fungicide treatments at harvest and three weeks after harvest on decay at Bosc pear wounds inoculated with the blue mold fungus, *Penicillium expansum*.

Treatment applied after harvest (initial)	Treatment applied 3 weeks after initial	Percentage of wounds infected (blue mold)[1]
Water	Water	99.3 a
Water	Mertect	94.7 a
Water	Penbotec	84.7 b
Water	Scholar	82.7 b
Mertect	Water	40.7 b
Mertect	Penbotec	14.7 c
Mertect	Scholar	13.3 c
Penbotec	Water	39.3 b
Penbotec	Mertect	16.7 c
Penbotec	Scholar	8.7 d
Scholar	Water	4.7 b
Scholar	Penbotec	2.0 b
Scholar	Mertect	1.3 b

[1] Values followed by the same letter are not significantly different (*P*>0.05). Comparisons apply to each group of three values in the column, compared to the check (water-water treatment).

Advances in postharvest decay research highlighted in this report, along with advances in other research programs in Washington and Oregon, emphasize significant technological opportunities that can improve postharvest decay management in pears. It is hoped that pear producers in the Pacific Northwest can benefit by having greater success in storing pears with minimal decay.